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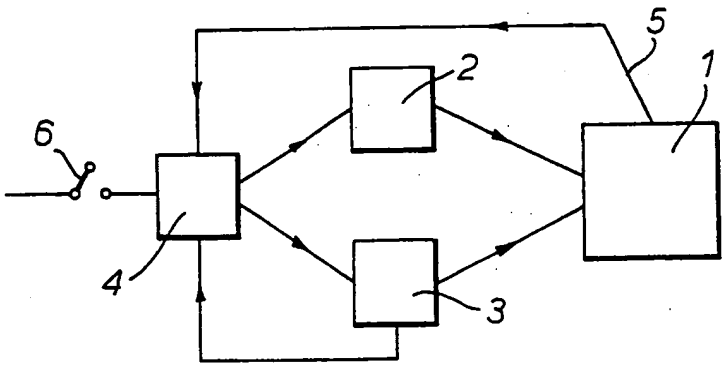

(57) Abstract

A method and an arrangement for starting an internal combustion Otto cycle engine (1), consisting of cylinders, a piston in each cylinder, a shaft and a flywheel (10), a fuel injection system (2), a spark plug ignition system (3) and a starter member, such a starter key (6). The piston in one of the cylinders is brought to the appropriate position for ignition and a signal of this position is transmitted from the engine (1) to a logical control device (4) along a feedback system (5). The logical control device (4) gives a signal to the fuel injection system (2) to inject air fuel mixture to the cylinder, and a signal to the ignition system (3) to ignite the spark in the cylinder.

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Method and arrangement of starting of internal combustion engines

The present invention relates to a method and an arrangement for starting a combustion engine, as set out in the prior-art portion of claims 1 and 5, respectively. The engine can be started without any external motor starting device conventionally provided for rotating the shaft of the internal combustion engine and intended for the starting of that engine with the Otto cycle in the combustion chambers.

The absolute majority of the internal combustion Otto cycle engines include in their set of related equipment a primary motor device which is used to rotate the shaft and the flywheel to initiate the injection and compression of the air-fuel mixture and its combustion in appropriate chambers and thus to start the action of the engine. As a primary starter it is known to use an electric motor fed by the energy from a rechargeable battery.

The major disadvantages of any implementation of the mentioned method are inevitably connected with the necessity to equip the engine with a powerful electric motor-starter and an appropriate high discharge current battery, powerful charging electric generator and a set of related minor electrical or electronic items.

DE application 3 117 144 and US patent publication 4 462 348 disclose arrangements by means of which a separate starting motor and a high charge battery can be avoided. These prior art arrangements use a detector and a microprocessor. The detector first senses the position of each cylinder for instance by means of the position of the crankshaft. The information given by the detector is processed by the microprocessor which defines the cylinder most advantageous starting the expansion stroke, and calculates for this cylinder the fuel amount, the ignition moment etc. corresponding to its position. The first expansion stroke has to be started even though the cylinder were further away from its optimal strting position so that the arrangements are not particularly efficient. Besides, they require a relatively complicated microprocessor for the control.

According to US patent publications 2 467 067 and 2 498 697, an electric starting motor is replaced by a hydraulic starting motor.

DE patent publication 253 897 discloses a Diesel engine provided with an ignition device which is used at the initial phase when starting the engine, before the pressure of the air is sufficient. The engine can first be rotated by hand.

DE patent publication 46 037 describes a method for starting an engine by opening the appropriate valve by hand after visual choice of a cylinder where the piston is in the upper position.

DE patent publication 184 676 proposes the use of an electromechanical system of distribution and initiation of the ignition of a carburettor type engine. This is done with a solenoid controlled valve which opens the way of the air-fuel mixture to the cylinders.

DE patent publication 260 492 describes a starting method where the piston of the fuel injection pump is mechanically connected with the system providing the movement of the engine pistons. The engine is equipped with manually operated valves for fuel mixture supply to each separate cylinder.

DE patent publication 700 356 describes a starting system in which the shaft is rotated by a special electrical motor. The engine is equipped with explosive starting charge mounted in the cylinder cover.

The object of the present invention as claimed is

- to simplify and diminish the set of equipment which forms the contemporary Otto cycle internal combustion engine,
- to make more effective and cleaner the exploitation of the engine providing its reliable starting, especially in cold environment,
- to make the most massive production of car (and truck) engines cheaper and so as well their exploitation.

The characteristics of the method and the arrangement of the present invention are set forth in the characterizing portion of claims 1 and 5, respectively.

The method in accordance with the present invention can be used in any Otto cycle internal combustion engine to elim-

inate the necessity of provision of any special starter-motor which initiates the process of fuel compression and combustion and the action of the mentioned engine by primary rotating of the main shaft and/or appropriate flywheel.

The method uses instead of a starter-motor a simple control device which operates a small air-fuel injection pump and initiates the ignition spark-plug (or spark-plugs in multicylinder engine) in appropriate order to begin the normal action of the engine without the necessity to use any external devices or forces prior to the beginning of the normal internal combustion process in appropriate combustion chambers of the engine. The method has application area in modernizing of any existing appropriate equipment or any newly built internal combustion engine. It can be used for both piston and rotary-type (Wankel) engines. (In further description this will be meant but the explanation will be made for piston type multicylinder engines as an example.)

The idea of the method is to inject the air-fuel mixture and to initiate its combustion in appropriate cylinder - namely in that one the piston of which has the position close enough to first degrees after its upper dead point. Next one in order for fuel injection and spark-plug ignition will be the cylinder the piston of which would have the mentioned position after the shaft and the flywheel of the engine have begun to turn. In other words, the further air-fuel injection and the ignition should follow as ordinary, normal procedure characteristics for a standard Otto cycle internal combustion engine.

The arrangement in accordance with the invention in the simplest form might be explained in application to the Otto cycle engine already equipped with fuel injection and electronic ignition systems. In this case the arrangement provides a simple electronic logical control device leaving just one problem to be solved. That is the demand to begin the fuel injection and to give the high voltage to the spark plug in appropriate cylinder when its piston is in the mentioned appropriate position.

At least two versions of arrangement could be suggested. First, to provide a small electrically driven pump-motor de-

vice which would turn relatively slowly the flywheel an angle to achieve the needed position of the pistons to begin the starting process described above. And second, to provide a small hydraulic device analoguous to the one mentioned in the first version, but not driven by a small electrical motor pump but by a pump operated by mechanical force e.g. in the case of automobile application by the existing hydraulic brakes system operated by the pedal. In the first version, the beginning and the end of the flywheel turning operation is done fully automatically by a logical control device which controls the whole engine-starting process beginning by key turn "on" action of the operator. In the second version, the process is supposed to be semiautomatic when the operator is informed by the flashing of an appropriate panel light that the pump action should be stopped. In both cases, the speed of the positioning movement of the flywheel is essentially slower than even the lowest actual running speed of the engine.

In accordance with the invention the arrangement in case of the Otto cycle engine which has a standard carburettor fuel supply system and a non-electronic standard ignition distributor system should include in addition to the devices mentioned above all elements needed for conversion of this engine to one having fuel injection and electronic ignition systems. In this case, the logical electronic device specific for this invention might be cooperated in one item with the electronic ignition system.

The invention in details is described more closely with reference to the accompanying drawing wherein Figure 1 is a schematic diagram of interacting engine systems, Figure 2 is a schematic diagram of the version of the electrical arrangement for turning the flywheel into an appropriate starting position, Figure 3 is a schematic diagram of the version of the mechanical arrangement for turning the flywheel into an appropriate starting position.

In the embodiment of Fig. 1, the Otto cycle engine 1 equipped with a fuel injection system 2 and an electronic ignition system 3 is operated by a starting logical control device 4 which has a feedback electrical connection 5 with

the distributor system, and which gives the signal for fuel injection and spark plug ignition in the appropriate cylinder after the starting key 6 is put in "on" position and the "permitting" connection signal comes to the control device 4 along the feedback line 5 confirming the appropriate position of the pistons in the cylinders.

Fig. 2 gives a schematic diagram of the arrangement for electrical activation of the turning of the flywheel 10 of the engine 1 with the help of a small hydraulic motor 9 and a pump 8 driven by a small power electrical motor 7 activated by the signal from the control device 4.

Fig. 3 illustrates a simplified mechanical version of the flywheel turning mechanism in application to the car engine arrangement operated by the pedal 12 of the hydraulic brake system which directly operates the pump 8. The confirmation of the needed position of the fly-wheel is given by a signal through the line 5 to the panel light 11 for operator's information as a permission signal for starting of the engine.

Preferably the injection is provided directly to the cylinders. However, the injection can be provided alternatively to the suction duct but the efficiency is then lower.

Claims

1. A method for starting an internal combustion engine (1), either of Otto cycle type consisting one or several cylinders and a piston in each cylinder, or a rotary-type engine; the engine further consisting of a shaft, a fuel injection system (2), a spark plug ignition system (3), a starter member, such as a starter key (6), and a logical control device (4) to which a signal of the position of one cylinder is transmitted along a feedback system (5), the logical control device (4) giving a signal to the fuel injection system (2) to inject air-fuel mixture to the cylinder or combustion chamber directly or via the suction duct and a signal to the ignition system (3) to ignite the spark in the cylinder or the combustion chamber, **characterized** in that the shaft of the engine is turned relatively slowly such an angle that the piston in one of the cylinders or in the combustion chamber is brought to the appropriate position for ignition, and that the spark is ignited only after that.

2. A method as claimed in claim 1, **characterized** in that the appropriate position of the piston for the initial combustion is achieved by a hydraulic motor (9) driven by a hydraulic pump (8), which hydraulic motor (9) turns the flywheel (10) part of its revolution to the needed position of the mentioned piston.

3. A method as claimed in claim 2, **characterized** in that the hydraulic pump (8) is driven by a low power electrical motor (7).

4. A method as claimed in claim 2, **characterized** in that the hydraulic pump (8) is driven by the pedal (12) of the hydraulic brake system of the car.

5. An arrangement for starting an internal combustion engine (1) either of Otto cycle type comprising one or several cylinders and a piston in each cylinder or a rotary-type engine; the engine further comprising a shaft, a fuel injection system (2), a spark plug ignition system (3), a starter member, such as a starter key (6), a logical control device (4) for receiving a signal from the engine of the position of a piston and for transmitting a signal to the fuel injection system (2) and to the ignition system (2), **charac-**

terized in that the arrangement further comprises means for rotating the engine shaft relatively slowly such an angle that the piston in one cylinder or combustion chamber achieves the appropriate position for ignition before the spark is ignited.

6. An arrangement as claimed in claim 5, characterized in that it is provided with a hydraulic motor (9) driven by a hydraulic pump (8) for turning the flywheel (10) over a part of its revolution in order to move a cylinder to the appropriate position for initial combustion.

7. An arrangement as claimed in claim 6, characterized in that it is provided with a low power electical motor (7) for driving the hydraulic pump (8).

8. An arrangement as claimed in claim 5, characterized in that it is provided with means to drive the hydraulic pump (8) by the pedal (12) of the hydraulic brake system of the car.

9. An arrangement as claimed in claim 8, characterized in that it is provided with an indicator (11) to inform the driver of the required position of the flywheel (10).

Fig. 1.

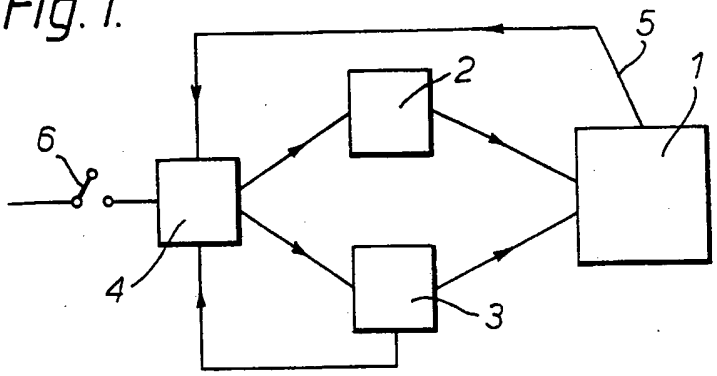


Fig. 2.

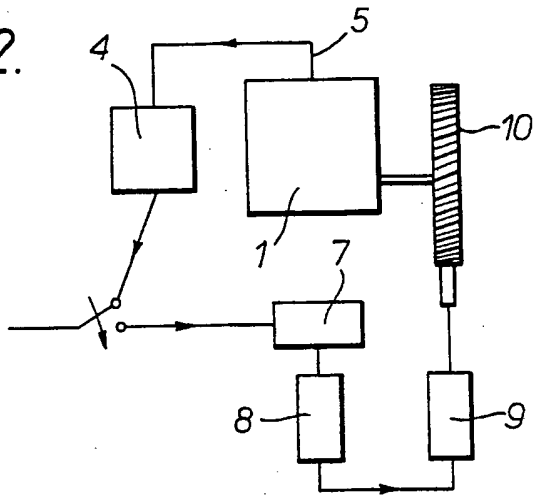
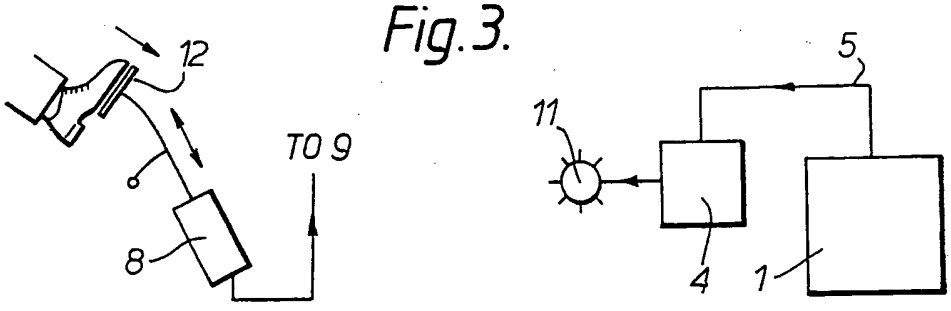


Fig. 3.



INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 92/00225

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: F 02 N 9/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	F 02 B; F 02 N

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	SE, B, 334508 (HUSQVARNA VAPENFABRIKS AB) 26 April 1971, see page 3, line 32 - page 4, line 11 --	1-3,5-7, 9
Y	GB, A, 2104969 (FORD MOTOR COMPANY LIMITED) 16 March 1983, see page 3, line 15 - line 79 --	1-3,5-7, 9
Y	DE, A1, 3117144 (EMIL BENDER) 18 November 1982, see page 4, line 21 - page 5, line 2 --	1-3,5-7, 9
A	SE, B, 372966 (A BRAUN) 20 January 1975, see page 6 --	1

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
19th November 1992	23 -11- 1992
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SWEDISH PATENT OFFICE	Herman Phalén

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. PCT/FI 92/00225

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
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